SHORT COMMUNICATION

Can larval lacewings *Chrysoperla externa* (Hagen) (Neuroptera, Chrysopidae) be reared on pollen?

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ABSTRACT. Can larval lacewings *Chrysoperla externa* (Hagen) (Neuroptera, Chrysopidae) be reared on pollen? The aim of this study was to verify the viability of exclusive use of elephant grass pollen, *Pennisetum purpureum* (Schum), to feed larvae of the lacewing *Chrysoperla externa* (Hagen, 1861). The insects were kept at 24ºC and the duration and survival rate of each instar and the larval and pupal phases were recorded. The diet provided complete development of the larvae. The average duration of the first and second instars was the same (6.9 days), while the third instar lasted an average of 10.0 days and the pupal phase 13.2 days. The average survival of the larvae was above 80% for the first, second and third instars, and 70.0% and 33.3% for the larval and pupal phase, respectively. These results indicate that the exclusive use of elephant grass pollen can provide complete development of the immature stages of this predator.

KEYWORDS. Diet; green lacewing; mass rearing.

RESUMO. Larvas de *Chrysoperla externa* (Hagen) (Neuroptera, Chrysopidae) podem ser criadas com pólen? O objetivo do presente estudo foi verificar a viabilidade do uso exclusivo de pólen de capim-elefante *Pennisetum purpureum* (Schum) como dieta para larvas de *Chrysoperla externa* (Hagen, 1861). Os insetos foram mantidos a 24ºC, avaliando-se a duração e a sobrevivência em cada instar e em todo o estágio larval e pupal. Verificou-se que a dieta proporcionou o desenvolvimento completo das larvas do crisopídeo, que apresentaram a mesma duração média para o primeiro e segundo ínstares (6,9 dias) e permaneceram 10,0 e 13,2 dias no terceiro instar e no estágio pupal, respectivamente. A sobrevivência média das larvas de *C. externa* foi superior a 80% para o primeiro, segundo e terceiro ínstares, e de 70,0% e 33,3% para o estágio larval e pupal, respectivamente. Verificou-se que o uso exclusivo de pólen de capim-elefante como alimento para larvas de *C. externa* proporcionou o completo desenvolvimento dos estágios imaturos do predador.

PALAVRAS-CHAVE. Criação massal; crisopídeo; dieta.

Insects, commonly called lacewings, in the family Chrysopidae (Neuroptera) show potential for control of insect pests (Lira & Batista 2006). Among the species that have been examined, *Chrysoperla externa* (Hagen, 1861) has been very useful in mass-release programs (Carvalho & Souza 2000). Mass, natural-enemy, rearing programs have advanced considerably and developed constant monitoring and control of diets for production maintenance (Oliveira *et al.* 2002). Despite the many studies of the ecology of the lacewing still much is yet to be learned, especially for the rearing and maintenance of large quantities for use in biological control (Gitirana Neto *et al.* 2001). For these large-scale release programs, rearing also must be carried out on a large scale in the laboratory (Albuquerque *et al.* 2001). Thus, one of the most important aspects of large-scale rearing is the quality of the diet that is fed to the larvae (Canard & Principi 1984; Carvalho & Souza 2000).

Insect larvae have salivary glands that produce enzymes for initiating the digestion process (Chapman 1998). These digestive enzymes may remain active in the intestines where they continue to carry out their principal role of degradation of plant polymers (Benjamin *et al*. 2004). Lacewing larvae have curved shaped mandibles that, when closed, form a canal (suction tube) for the passage of food (Gepp 1984; Carvalho *et al*. 2003). By means of this canal, the insect can inject digestive enzymes into the prey, after which it can suck the partially digested tissues and organs (Cohen 1998). Lacewing larvae are predators on several types of prey, such as Lepidopteran eggs and larvae, aphids, scale insects and mites (Carvalho & Souza 2000). Lacewings also eat leaf-hoppers, white flies, thrips and many other, soft-bodied arthropods (Ribeiro *et al.* 1991; Berti Filho *et al*. 2000). Adult lacewings may eat pollen (Hagen & Tassan 1970; Sheldon & MacLeod 1971; Agnew *et al.* 1981). Some species take "honeydew" and nectar as well as species that continue to prey on the same foods that they take as larvae (Sheldon & MacLeod 1971).

The wide diversity of prey taken by lacewings suggest that these insects may be very useful in biological control on pest arthropods. However, in nature their population sizes are usually too small to be effective. Therefore, captive rearing in large numbers for later release is required for effective use in agriculture. However, such rearing is not easy and methods to effectively rear these animals at reasonable costs must be developed.

Pollen has been studied as food for lacewing adults (Boregas *et al.* 2003; Venzon *et al.* 2006). A promising plant for pollen as food is the elephant grass (*Pennisetum purpureum* Schum). It is already used for grazing (Costa & Gonçalves 1988) and is now found throughout Brazil (Pereira *et al.* 2001). Its pollen-rich inflorescence in the form of a spike is about 15 cm long and may easily be collected and used for laboratory diets.

In rearing lacewings, eggs of the grain moth *Sitotroga cerealella* (Olivier, 1819) (Lepidoptera, Gelechiidae) and the flour moth *Anagasta kuehniella* (Zeller, 1879) (Lepidoptera, Pyralidae) are the most commonly used throughout the world, although alternative food sources may be used (Freitas 2001). When using eggs from these moths, the moths themselves must also be reared to produce enough eggs to then use to rear lacewings. Or, the moth eggs must be bought from another source. Therefore, neither method is ideal and both are costly (Cohen & Smith 1998; Tauber *et al.* 2000). Thus, alternative, inexpensive yet nutritious food sources must be developed for the effective rearing of lacewings (Carvalho & Souza 2000).

To that end, lacewings were studied at the Experimental Field Station for Dairy Cattle of Embrapa (21º33'22''S, 43º06'15''W, altitude de 410 m), in Coronel Pacheco, in the state of Minas Gerais. From March to June 2007 lacewing larvae were found in the field in inflorescences of *Brachiaria decumbens* Stapf. In searching the same places for prey species of the lacewings, none was found, giving rise to the possibility that the lacewing larvae were consuming pollen (S. A. Oliveira, pers. com.).

With these observations, here, we tested whether pollen of the elephant grass *P. purpureum* may serve as an efficient and cost-effective food source for rearing the lacewing *C. externa.*

Eggs were used from the Entomology Laboratory of the Federal University of Lavras (UFLA) in the state of Minas Gerais. Thirty recently hatched lacewing larvae (F3 generation) were placed in Petri dishes (5 cm diameter) covered with perfurated plastic film. Larvae were kept at 24ºC, 70 ± 10% relative humidity, 12h photoperiod and fed daily on elephant grass pollen moistened in distilled water. Pollen was gathered at the Dairy Cattle field station and stored at 5ºC in hermetically sealed jars. Lacewing larvae were checked daily to monitor survival and growth of each instar and through the pupal stage.

Pollen diet resulted in complete development of the lacewing. Average duration for the first and the second instars was 6.9 days (d) each, the third instar lasted 10.0 d and the pupal stage lasted 13.2 d (Figure 1). Other studies that used aphids (Hemiptera, Aphididae), *Schizaphis graminum* (Rondani, 1852) - Fonseca *et al.* (2001); *Rhopalosiphum maidis* (Fitch, 1856) - Maia *et al.* (2004); *Aphis gossyppi* Glover, 1877 - Costa *et al.* (2002) and Pessoa *et al.* (2004); *Hyadaphis foeniculi* (Passerini, 1860) - Lira & Batista (2006); *Cinara* spp. - Cardoso & Lazzari (2003), as prey for larval lacewings had somewhat shorter intervals for development than in this

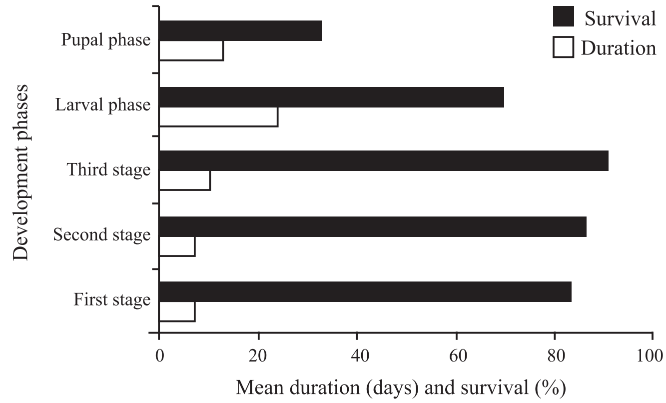

Fig. 1. Mean duration (d) and survival (%) during the first through third instars, total larval and pupal stages, of the lacewing *Chrysoperla externa* (Hagen, 1861) (Neuroptera, Chrysopidae) fed on pollen from elephant grass *Pennisetum purpureum*.

study: the first instar lasted 2.3-4.0 d, the second lasted 2.5-3.3 d, the third lasted 3.5-5.4 d and the total larval stage lasted 10.0-11.1 d. Other hemipterans used as prey also resulted in more rapid development [*Bemisia tabaci* (Gennadius, 1889) (Aleyrodidae) - Auad *et al*. 2001, 2005 and Silva *et al*. 2004); *Dysmicoccus brevipes* (Cockerell, 1893) (Pseudococcidae) - Gonçalves-Gervásio & Santa-Cecília (2001)]. Moth larvae as prey also resulted in faster development (Figueira *et al*. 2000; Boregas *et al*. 2003; Bortoli *et al*. 2006). Thus, while a diet of pollen resulted in slowed growth, development to the adult stage occurred, demonstrating that a pollen diet is a viable alternative to *C.externa* larvae.

Survival on a pollen diet was also relatively high. During instar 1 survival was 83.3%, instar 2 was 86.5% and instar 3 was 91.3%, for the total larval stage was 70% and for the pupal stage was 33.3% (Fig. 1). These survival rates were similar to published values when fed on moth larvae (Costa *et al*. 2002) and when fed on a variety of other pest insects (Figueira *et al*. 2000). Thus, while development rate may be somewhat slower, survival rate was similar when comparing pollen versus insect diets. However, the low survival rate observed for the pupal stage suggests that a pollen diet may be used as a supplement rather than a main diet. Therefore, here we demonstrate that a pollen diet can be a viable supplementary alternative for rearing the lacewing *C. externa* larvae, reducing costs, and eliminating the need to rear large amounts of insect prey.

For healthy development, nutritional demands of *C. externa* include proteins, amino acids, carbohydrates, sugars, vitamins and salts (Hagen & Tassan 1970; House 1977). Pollen has around 14 carbohydrates (Panizzi & Parra 1991). Pollen is also very digestible with as much as 60% protein (Roulston & Cane 2000). Thus, pollen clearly can offer a high quality diet during both immature and mature life stages. Therefore, we recommend the use of pollen as an important component in the diet for rearing large numbers of *C. externa* in the laboratory.

Success of the lacewings in integrated pest management depends on the ability of the insect to survive and reproduce in the places where they are released (Angelini & Freitas 2006). This may explain why lacewing populations sometimes grow while the plants are in flower. Exclusive use of pollen from elephant grass can be sufficient to allow the complete growth and development of the lacewing *C. externa* in the laboratory. Thus, pollen, previously described as only an item in the diet of adult lacewings, may also be an important supplement of the diet in larval stages. This suggests that the maintenance of pollen sources near crops of agricultural importance may increase the survival of pest predators. Thus, we recommend the use of pollen to develop rearing programs as well as planting of pollen-rich plants near cultivation as a means of providing a constant diet for the predators of plant pests.

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